Diabetes Ketoacidosis Emergency Department Evaluation Pathway
Evidence Based Outcome Center

**Inclusion Criteria**
- Hyperglycemia &/or Glucosuria &/or Ketonuria
- Historical features suspicious of diabetes

**PALS and ISPAD Assessments**
- Vital Signs: Temp, Heart rate (HR), Respiratory rate (RR), and Blood pressure (BP)
- Notify MD if Cushing’s Triad is present (↓ HR, ↑ BP, widening pulse pressure)
- Cardiorespiratory monitoring
- Altered mental status
- Young age

**Assess Neurologic Stability & Risk of Cerebral Edema**
Consider assessment for patients at high risk for cerebral edema complications
- Glasgow Coma Scale (GCS)

**Initial Fluid Resuscitation**
20 mL/kg NS Bolus over 30 minutes | 1 L Max Then 2X Maintenance IV Fluids.
Consider adjustments based on fluid given prior to arrival at DCMC.

**Initial Diagnostic Labs:**
Consider expanding labs for high risk for cerebral edema complications
- Notify Endocrinologist on Call
- Hemoglobin A1C
- VBG, CBG, OR ABG with lytes/Ca
- BMP
- Magnesium
- Quantitative Beta hydroxybutyrate – STAT (B-HB)

*Consider urinalysis with culture if febrile

**Meet DKA Definition**
1) pH < 7.3 AND HCO₃ < 18
2) Hyperglycemia > 200 mg/dl
3) AND Ketones in Urine OR High risk for complications *CONSULT ENDOCRINOLOGY*

**Meet Ketosis Non-Acidosis Definition**
1) pH ≥ 7.3 OR HCO₃ ≥ 18
2) Hyperglycemia > 200 Mg/dl
3) AND Urine Ketones > Small OR B-HB > 1

*CONSULT ENDOCRINOLOGY*

**Initial ED Orderset:** ADMIT to PICU
- Cardio-respiratory Monitor and Pulse Oximeter
- Vital signs with neuro check Q 1 Hour
- Intake and output recorded
- Blood sugar by glucometer Q 1 Hour
- Suspend insulin pump if applicable to patient
- Consult Endocrinology

Consider a single dose of long-acting insulin (insulin glargine or insulin detemir), after consult w/ Endocrinology, if transport to PICU is expected to be > 60 minutes.

**Notify PICU attending for any of the following:**
- Glucose < 80 mg/dL
- Glucose falling > 100 mg/dL/Hour
- Urine output < 1mL/kg/hour over 2 hours OR negative fluid balance
- Intractable vomiting
- Change in mental status (including severe or increasing headache)

**Ketosis Non-acidosis Pathway**
1. **High risk of cerebral edema**
   - Severe headache
   - Recurrent vomiting
   - History of Cerebral Edema
   - Depressed mental status

   **IV Fluids**
   - If patient is high risk for cerebral edema use NS
     - Corrected Sodium level > 140 mEq/L: ½ NS
     - Corrected Sodium level < 140 mEq/L: NS

     Corrected Sodium = Measured sodium + 0.016 * (Serum glucose - 100)

**Admit to PICU**

**Assess for Hyperglycemia hyperosmolar state**
Consult Endocrinology Manage Off Pathway

**Cerebral Edema Treatment Pathway**

**Signs of herniation**
- Bradycardia/hypertension/respiratory insufficiency
- Anisocoria (Unequal pupil size)
- Unresponsiveness

**High Risk for Cerebral Edema**
1. Notify PICU AND plan for ADMIT
2. High risk cerebral edema

**Signs Suggestive of DKA**
Clinical Signs
- Dehydration
- Vomiting
- Kussmaul breathing
- Abdominal tenderness
- Lethargy
- Mental status changes
- Smell of ketones (fruity smell)

**Historical Features**
- Polyuria/Polydipsia
- Fatigue
- New onset enuresis
- Nausea/vomiting
- Nocturia
- Headache
- Weight loss
- Confusion
- Abdominal pain
- New Candida infection

**EXCLUSION CRITERIA**
- Change in mental status
- Intractable vomiting
- Urine output
- Glucose falling
- Glucose

**LAST UPDATED MARCH 7, 2016**
Diabetes Ketoacidosis Intensive Care Unit Management Pathway
Evidence Based Outcome Center

EXCLUSION CRITERIA
- Age < 12 months

Inclusion Criteria
1) pH < 7.3 AND HCO₃ < 18
2) Hyperglycemia > 200 mg/dl AND
3) Urine Ketones present

Fluid titration: Total fluid rate 1.5 x maintenance
- While patient is acidic maintain NPO status
- If Potassium (K+) < 5.5 mEq/dL AND patient is voiding well discontinue normal saline and initiate two bag system

Assess Neurologic Stability & Risk of Cerebral Edema: q1hr
- High Risk for Cerebral Edema: Decrease insulin AND consider hypertonic saline (3%)

Labs:
- Blood glucose by glucometer: q2hr
- VBG w/lytes, CBG w/lytes OR ABG w/lytes: q2hr
- Serum B-Hb: q4hr
- BMP: q4-q12hr
- Magnesium & Phosphorus: q8-q12hr

Additional Labs:
- Serum Osmolality (OSM) — if patient is high risk for Cerebral Edema, glucose is increasing, or high initial OSM
- Urinalysis with micro, Urine Culture, or Throat Culture — if patient history supports

Monitoring:
- Vital signs q1hr
- Cardio-respiratory monitor, pulse oximeter, strict I & Os including po intake

Other medication:
- Famotidine (Pepcid) 0.5 mg/kg/dose | Max: 20 mg/dose q12hr
- Ondansetron (Zofran) 0.1 mg/kg | Max: 4 mg dose IV prn q12hr
- Long-acting insulin (insulin glargine or insulin detemir): Contact Endocrinology for dose

Fluid titration based on serum glucose:

<table>
<thead>
<tr>
<th>Serum glucose (mg/dL)</th>
<th>D10 NS – 30 mEq Potassium Acetate/Liter + 30 mEq Potassium Phosphate/Liter</th>
<th>NS + 30 mEq Potassium Acetate/Liter + 30 mEq Potassium Phosphate/Liter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 120</td>
<td>100% = _____ ml/hr</td>
<td>Off</td>
</tr>
<tr>
<td>120 – 200</td>
<td>66% = _____ ml/hr</td>
<td>33% = _____ ml/hr</td>
</tr>
<tr>
<td>201 – 300</td>
<td>33% = _____ ml/hr</td>
<td>66% = _____ ml/hr</td>
</tr>
<tr>
<td>Greater than 300</td>
<td>Off</td>
<td>100% = _____ ml/hr</td>
</tr>
</tbody>
</table>

If glucose > 300 but is falling greater than 100 mg/dL per hour, start fluids as follows and resume fluid titration as above once serum glucose less than or equal to 200 mg/dL:
- 50% = _____ ml/hr
- 50% = _____ ml/hr

For questions concerning this pathway, Click Here
Last Updated April 18, 2016
Cerebral Edema Treatment Pathway
Evidence Based Outcome Center

Risks for Cerebral Edema:
- New-onset diabetes
- History of prolonged DKA (several days)
- Extended history of poor diabetic control leading to chronic hyperosmolality
- Age < 5
- Moderate-to-severe acidosis (serum pH < 7.2)
- Elevated BUN
- Provision of > 4L/M2/day of fluids
- Excessive swings of serum glucose, plasma osm., and serum pH
- Variable rate of fluid replacement
- Rate of decrease of serum glucose >100 mg/dL/hour
- Failure of serum Na to increase as serum glucose decreases
- Rapidly decreasing plasma osmolality or critically low plasma osmolality during the first 24 hours of therapy
- Osmolality may be calculated as: \[ \text{Posm} = 2 \times [\text{Na}^+] + [\text{Glucose}] / 18 + [\text{BUN}] / 2.8 \]
- In general, it is sufficient to monitor serum Na and glucose, rather than explicitly calculate osmolality

Signs of Cerebral Edema
- Severe headache
- Mental status changes (e.g., irritability, decreased cooperation, disorientation, decreased level of consciousness)
  - Many patients in DKA are lethargic, but this usually improves quickly on therapy.
- Bradycardia/hypertension/respiratory insufficiency (Cushing's triad)
  - Be aware of the normal heart rate for the age.
  - The heart rate in a patient with DKA should decrease with IV fluid therapy, but not to below the normal range.
- Recrudescence of vomiting
  - Most patients in DKA are vomiting on presentation, but this should improve on therapy.
- One or both pupils fixed and dilated
- Papilledema
- Focal neurologic signs
- Polyuria secondary to diabetes insipidus or, conversely, oliguria secondary to syndrome of inappropriate antidiuretic hormone (SIADH)
- Coma

Initiate treatment as soon as the condition is suspected and in the following order!

Call PICU and Endocrinology

Airway Protection
Intubation may be necessary for the patient with impending respiratory failure or GCS < 8, sustained hyperventilation has been associated with poor outcome.

Maneuvers and IV Fluids
- Reduce the rate of fluid administration by one-third.
- Elevate the head of the bed and keep head positioned midline

Hyperosmolar Therapy
- Hypertonic saline (3%), 5–10 mL/kg over 30 minutes
  AND/OR
- Mannitol 0.5–1 g/kg IV over 20 minutes and repeat if there is no initial response in 30 minutes to 2 hours

After Treatment Care and Considerations
- Consult Neurosurgery regarding possible ICP monitor
- After treatment for cerebral edema has been started, a cranial CT scan should be obtained to rule out other possible intracerebral causes of neurologic deterioration (≈10% of cases), especially thrombosis or hemorrhage, which may benefit from specific therapy.
**Ketosis Non-Acidosis Emergency Department Pathway**

**Evidence Based Outcome Center**

**Inclusion Criteria**
1. pH > 7.3 OR HCO$_3$ > 18
2. Hyperglycemia > 200 Mg/dl
3. AND Urine Ketones > Small OR β-HB > 1

**Discharge Criteria:** Consult Endocrinology
- Urinary ketones are trace to negative
- OR β-HB decreasing or < 0.6 mmol/L
- Blood glucose < 200 mg/dl OR decreasing
- AND Patient is tolerating PO

**Discharge Instructions**
Use ED Diabetic Ketosis Sick Day Plan
Consult Endocrinology

**PICU Admission Criteria:**
- pH < 7.3 AND HCO$_3$ < 18
- Hyperglycemia > 200 Mg/dl
- Corrected Na > 150
- AND Ketones in Urine

**Inpatient Admission Criteria:**
- Ketones Large to Moderate OR β-HB > 2 mmol/L
- Not Tolerating PO
- Psychosocial issues that necessitate inpatient treatment

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**Initial Insulin Dose**

**After Initial Insulin Dose**

**Corrected Sodium**

**Serum B**

**Urine dipstick for ketones**

**Venous blood glucose**

**Strick I**

**Neuro check**

**Pulse Oximetry**

**Cardiac monitor**

**Vital signs**

**TIME**

**EXCLUSION CRITERIA**
- Age < 12 months
- Diabetic Ketoacidosis
- Cerebral Edema
- Hyperosmolar state
- Cystic Fibrosis
- New onset diabetic

**TIME: 0 Initial Insulin Dose**

**TIME: 90 Minutes After Initial Insulin Dose**

**TIME: 120 Minutes After Initial Insulin Dose**

**IV fluids**

- Reduce to maintenance
- Encourage water intake

**Administer Zofran: 0.1 mg/kg | Max 4 mg AND Continue IV Fluids at 2 times maintenance**

**NO**

**YES**

**Tolerating PO?**

**TIME: 0 Initial Insulin Dose**

**TIME: 90 Minutes After Initial Insulin Dose**

**TIME: 120 Minutes After Initial Insulin Dose**

**Consider meals or 30 gram snacks (Possible Sources of Snacks)**
- The dose of insulin for the meal is based on the patient's insulin to carbohydrate ratio at home. This dose should be given at patients regularly scheduled 2hr interval.

**Do not give insulin more frequently than every 2 hrs.**

**Order Quantitative β-hydroxybutyrate – STAT and VBG Labs**

**Give insulin according to the patient's insulin to carbohydrate ratio (ICR) AND consider 30 gram snack (Possible Sources of Snacks)**

**Order Quantitative β-hydroxybutyrate – STAT and VBG Labs**

**IV fluids**

- Corrected Sodium level ≥ 140 mEq/L: ½ NS
- Corrected Sodium level < 140 mEq/L: NS

Corrected Sodium = Measured sodium + 0.016 * (Serum glucose - 100)

**Frequency of Labs**
- Venous blood glucose: q1hrs
- Urine dipstick for ketones: qvoid
- Serum β-hydroxybutyrate and VBG: 90 minutes after initial insulin dose

**Monitoring**
- Vital signs: q1hrs
- Cardiac monitor
- Pulse Oximetry
- Neuro check: q1hrs
- Strick i & Os, including po intake

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**Final Updated March 7, 2016**

**For questions concerning this pathway,**

**Click Here**
Assessment for patients at high risk for cerebral edema complications

- Age < 24 months
- GCS < 13 after volume resuscitation
- Presenting pH < 7.15
- Presenting HCO₃ < 5 mEq/L
- Presenting PCO₂ < 10 mmHg
- Presenting BUN > 30 mg/dL
- Calculated Serum osmolality > 350 [ 2 x Na + (glucose/18) + (BUN/2.8)]
- Corrected Na < 140 mEq/L or decreasing at 2 hour labs
- Patient received IV bicarbonate or insulin bolus
- Patient received > 40 mL/kg total initial volume replacement (include fluids received prior to arrival to DCMC)
- Developmental delay or any condition that compromises communication
- Abnormal neurological exam after volume resuscitation
- Other organ system dysfunction
- History of Cerebral Edema
- Intractable vomiting
- Glucose > 800 mg/dL

Hyperglycemic Hyperosmolar State (HHS) criteria

Hyperglycemic hyperosmolar state (HHS), also referred to as hyperosmolar nonketotic coma, may occur in young patients with T2DM, but rarely in T1DM subjects.

**Criteria for HHS include:**
- plasma glucose concentration >33.3 mmol/L (600 mg/dL)
- arterial pH >7.30
- serum bicarbonate >15 mmol/L
- small ketonuria, absent to mild ketonemia
- effective serum osmolality >320 mOsm/kg
- stupor or coma

Possible sources of snacks

<table>
<thead>
<tr>
<th>Snack</th>
<th>Volume</th>
<th>CHO</th>
<th>Snack</th>
<th>Volume</th>
<th>CHO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saltine Crackers</td>
<td>1 Pkg (2 crackers)</td>
<td>4 grams</td>
<td>Graham Crackers</td>
<td>1 Pkg (3 crackers)</td>
<td>15 grams</td>
</tr>
<tr>
<td>Jello Snacks</td>
<td>1 Pkg (8oz)</td>
<td>17 grams</td>
<td>Pudding Snacks</td>
<td>1 Pkg (8oz)</td>
<td>23 grams</td>
</tr>
<tr>
<td>Peanut Butter Crackers</td>
<td>1 Pkg (6 crackers)</td>
<td>23 grams</td>
<td>Gatorade</td>
<td>8oz</td>
<td>14 grams</td>
</tr>
</tbody>
</table>